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TREFOIL PRODUCTION

FOR PASTURE AND HAY

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U.S. DEPARTMENT OF AGRICULTURE

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TREFOIL PRODUCTION

FOR PASTURE AND HAY

The perennial trefoils—birdsfoot, narrow-leaf, and big trefoil—are increasingly important pasture and hay legumes on a number of soil areas in the U.S. From a cautious beginning, acreage and production of the trefoils have expanded steadily.

ADVANTAGES

The trefoils offer these advantages:

- They produce well on soils less fertile than needed for alfalfa, and on soils that are poorly drained or heavily textured, or that have high clay, saline, or alkaline content.

- Once established, they provide exceptionally long-lived permanent pasture for grazing and cover.

- They make high-quality hay and silage.

- They compare favorably in feeding value with other common legumes.

- They persist during drought and grow well in midsummer.

- They readily reseed and spread.

- They do not cause bloat in cat-

tle or sheep, even when grazed in pure stands.

- They grow well on fertile soils in permanent pastures that are left down a long time and on land too rolling to cultivate or renovate.

Birdsfoot trefoil, the most widely grown of the trefoils, produces hay that compares well in protein value with alfalfa hay cut at like stages of growth.

In Indiana tests, the carotene (vitamin A) content of birdsfoot hay was higher throughout the season than the carotene content of alfalfa or ladino clover hay. Birdsfoot hay also loses less carotene in drying of comparative cuttings than alfalfa or ladino clover.

DISADVANTAGES

Two factors have limited the use of the trefoils—(1) satisfactory trefoil stands are hard to establish, compared with alfalfa, red clover, and other forages, and (2) trefoil seed is difficult to harvest.

Practices gradually overcoming these disadvantages include:

- Band seeding or drilling over fertilizer for better stands and reduced seeding cost.
- Applying selective herbicides for control of weeds and weed grasses in trefoil fields.
- Defoliating or partly defoliating green trefoil plants with chemicals before direct combining of seed crop.
- Mowing and drying trefoil in the swath for 8 to 24 hours before combining seed.

SPECIES AND ADAPTATION

Birdsfoot Trefoil

Description

Birdsfoot trefoil is a broad-leaved, perennial legume similar to alfalfa in growth habit. It has a well-developed, branching taproot with stems ascending from each crown. Plants are erect and reach a height of 12 to 30 inches.

Stems are slender and moderately leafy, with five leaflets to a petiole. Flowers are yellow with faint red and orange stripes, usually number two to six, and somewhat resemble pea flowers. Pods form at right angles to the end of the flower stalk in the shape of a bird's foot; hence the name of the species. Seeds are light to dark brown, and are speckled with dark spots; they are oval to spherical in shape.

Where Grown

Birdsfoot trefoil is generally adapted to the temperate climate of the northern part of the U.S., where it is a pasture and hay crop of ma-

jor importance on less fertile, poorly drained soils. It also has a place on fertile soils in permanent pastures that are left down for long periods or in pastures that are hard to cultivate.

Birdsfoot is not recommended south of a line drawn from the eastern tip of the Nebraska-Kansas border to the east coast except at higher elevations in the Appalachian Mountains. Stands south of this line are susceptible to crown- and root-rotting diseases.

Narrowleaf Trefoil

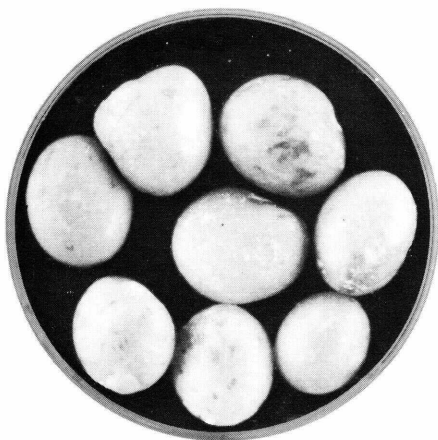
Description

Narrowleaf trefoil has narrow, linear, tapering leaflets on slender, weak stems. It has a shallower root system and fewer and smaller flowers than birdsfoot. Flowers are yellow to orange and are arranged in clusters. Stems grow flat along the ground, and many stems rise from a single crown.



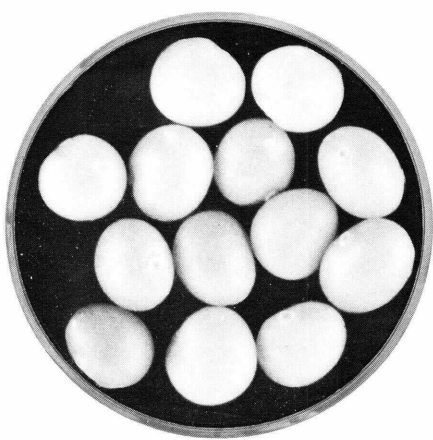
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A close-up of birdsfoot trefoil plant, showing flowers and seed pods. Seed pods form at right angles to flower stalk in shape of bird's foot. Birdsfoot trefoil, a fine-stemmed, broad-leaved perennial, produces high-quality pasture.



BN-16778-X

Birdsfoot trefoil seeds, greatly enlarged. Seeds are speckled with dark spots. Narrowleaf trefoil seeds closely resemble birdsfoot seeds.



BN-16777-X

Big trefoil seeds are unspeckled, much smaller than birdsfoot seeds, and are spherical.

Narrowleaf trefoil, in general, is not as hardy as birdsfoot. Of the narrowleaf strains, New York narrowleaf is somewhat more winter hardy than those from the West.

Where Grown

Narrowleaf is well suited to heavy, poorly drained soils in the northern part of the U.S. It is an integral part of pastures in the Hudson River Valley of New York State, and does well on heavy-textured clay soils and on saline and alkaline soils in California. Narrowleaf also thrives on similar soils in the Rogue River Valley of southern Oregon, where winters are relatively mild.

Big Trefoil

Description

In general appearance, big trefoil resembles birdsfoot. The chief difference between big trefoil and other species is vigorous growth of its rhizomes, a characteristic that spreads the plant and forms a solid stand. The flowers, which are brilliant yellow, are more numerous

than those of birdsfoot and narrowleaf.

Big trefoil is shallow rooted and lacks drought resistance. Unspeckled seeds are spherical, much smaller than birdsfoot seeds, and range in color from yellowish to olive green.

Where Grown

The range of adaptation for big trefoil is not fully determined, but it grows best on continuously moist soils and in regions where summer rains are frequent. It does well on acid, coastal soils of the Pacific Northwest, especially on areas that are frequently flooded during the winter months, and on relatively moist uplands.

Unlike birdsfoot, which requires lime on very acid soils for maximum production, big trefoil grows well on acid soils without lime application. Big trefoil is a promising pasture legume in the acid flatwood soils of the southeast coastal regions when adequately fertilized with phosphate and potassium. Productivity in this region is reduced during periods of warm, dry weather.

VARIETIES

Birdsfoot Trefoil

Present varieties come either from established stands in New York State or from European lots. Erect-growing varieties, such as Cascade, Granger, Viking, Tana, Mansfield, and Douglas, are recommended for hay or rotational pasture; semierect or spreading varie-

ties, such as Empire and Empire strains, for permanent and close-grazed pasture.

Empire.—Semierect, hardy, late-maturing, with leafy, many-branched stems. Flowers 10 days to 2 weeks later than common European forms. Once established, exceptionally long-lived and productive for pasture and hay. Persists

under continuous close grazing. Developed and released by Cornell University Agricultural Experiment Station, Ithaca, N.Y.

Cascade.—Erect-growing, productive, early-maturing variety with good seedling vigor. Relatively easy to establish. Not as hardy as Empire. Not grown in regions with extremely cold winters. Developed cooperatively by Washington Agricultural Experiment Station, Pullman, Wash., and the U.S. Soil Conservation Service, from plants imported from France.

Granger.—Erect, broad-leaved, early-maturing, productive variety. Similar to Cascade. Good seedling vigor and easily established. Not as hardy as Empire. Developed cooperatively by Oregon Agricultural Experiment Station, Corvallis, Oreg., and the U.S. Agricultural Research Service.

Viking.—Productive, rapid-growing variety developed by crossing plants from Danish stock with two New York State strains. Erect, broad-leaved, with good seedling vigor. More winter hardy than Cascade, Granger, or imported stocks from France and Italy. Developed and released by Cornell University Agricultural Experiment Station, Ithaca, N.Y.

Mansfield.—Erect-growing, similar to Viking, and adapted to same general areas across the Northern States. To develop Mansfield, several hundred superior plants were combined from three seed sources. Developed and released by Vermont Agricultural Experiment Station, Burlington, Vt.

Tana.—Vigorous, erect-growing, broad-leaved selection from high-yielding European seed lot. Good seedling vigor. Closely resembles Cascade and Granger. Developed and released by Montana Agricultural Experiment Station, Huntley, Mont.

Douglas.—Erect-growing, vigorous type. Originated in Douglas County, Oreg., where it gave best results of several European lots of birdsfoot trefoil under test.

Narrowleaf Trefoil

Los Banos.—New variety developed and released by California Experiment Station, Pleasanton, Calif., and the U.S. Soil Conservation Service. Only named variety.

State seed stocks.—Usually carry name of State of origin, such as New York, Oregon, or California narrowleaf. All varieties have fine stems and narrow leaves, and grow close to the ground.

Big Trefoil

Two varieties—developed by the Oregon Agricultural Experiment Station, Corvallis, Oreg., and the U.S. Agricultural Research Service—are available. Both are well suited to the wet winters and cool summers of the Pacific coastal areas of the Northwestern States.

Beaver.—Distinguished by hairy leaves and stems. Plant has a gray-green appearance.

Columbia.—Smooth leaved, with relatively few hairs. Foliage is dark green and resembles birdsfoot trefoil in general appearance.

ESTABLISHMENT

Seedling plants of trefoil lack vigor and do not compete with nurse crops, weeds, and grasses as well as do those of other legumes.

Good stands of the trefoils can be established by carefully following recommendations concerning—

- Seed quality.
- Fertilizing.
- Seedbed preparation.
- Inoculation.
- Method of seeding.
- Time and rate of seeding.
- Weed control.

Seed Quality

Trefoil seed is usually uneven in quality. Choose seed that is plump, relatively free from badly shriveled seed, and that tests high in germination.

Tests on many seed stocks show that, with few exceptions, large, plump seed produces the most vigorous seedlings. There is also a correlation between the weight of the seed and the height and weight of the young seedling plant.

Fertilizing

Birdsfoot trefoil resembles red clover in lime and fertilizer requirements. Lime is needed on acid soils; less fertile soils generally require phosphate. Potash is needed in many areas.

Narrowleaf and big trefoil are similar to birdsfoot in fertilizer needs.

If you do not know the fertilizer needs of a trefoil field, get an analysis of soil samples. Apply lime and fertilizer as indicated by soil tests.

Seedbed Preparation

A fine, firm seedbed is needed to produce vigorous trefoil seedlings. Seedlings usually fail when made on grass sod without seedbed preparation. Plow well in advance of seeding to permit rains or irrigation to settle the seedbed. The seedbed may then be disked, harrowed, and rolled or cultipacked before seeding.

The amount of seedbed preparation needed varies with kind of soil, moisture content, and season.

Inoculation of Seed

Inoculation is necessary for successful stands in areas where the trefoils have not been grown. Bacteria that inoculate alfalfa, red clover, and other common legumes are not effective on trefoils.

Strains of bacteria that inoculate birdsfoot and narrowleaf trefoil may not be effective on big trefoil. *Buy and use specific inoculum in seeding any of the trefoils.* Follow the directions on the inoculum container.

Seeding

Use one of the following methods in seeding trefoil:

- Band seeding or drilling.
- Seeding with cultipacker seeder.
- Broadcasting seed with cyclone seeder.

More uniform and satisfactory stands of trefoils usually result from band seeding or drilling than from other methods.

To band seed, drill fertilizer in

bands 1½ to 2 inches deep and drop seed directly over the fertilizer after soil has settled back. If you do not have a band seeder, you can adapt a grain drill with tubing (garden hose) so that the seed is dropped above the fertilizer band in the row behind the drill shoe.

Cover seed with a packer wheel attached to drill or by rolling the field with a corrugated roller. Cover the seed to a depth of ⅓ to ½ inch only. Do not cover too deeply.

Time and Rate of Seeding

Early spring seedings are generally most successful in the central and northern parts of the United States. Seeding date varies from late March in the southern part of this region to mid-June in the North. Fall or February seedings are recommended in California.

Big trefoil is seeded in March in Oregon; in the fall in Florida.

Four to six pounds of good-quality birdsfoot and narrowleaf trefoil seed per acre gives good results. Two to three pounds of big trefoil seed per acre is enough for good stands. Seed stocks containing a high percentage of hard seed should be scarified before seeding.

Weed Control

Trefoil seedlings grow slowly and need protection from rapidly growing weeds and weed grasses to survive.

To combat weed competition in trefoil pastures and seed crops, apply selective herbicides, mow, or graze lightly. Sometimes a combination of methods is needed.

Broadleaf weeds, such as ragweed and pigweed, may be partly controlled by mowing close to the ground when they have reached a height of 10 to 15 inches. Repeat mowings if necessary. For second and later mowings set the mower at a height of 3 to 4 inches to reduce injury to the trefoil plants.

Weed grasses—foxtail, crabgrass, fall panicum—are more injurious to seedlings than the usual broadleaf weeds, and often occur along with weeds in new seedings of trefoil. Mowing makes the grass weed problem worse unless herbicides are also used. When weed grasses are present, use a combination of treatments.

Where practical, weeds can be partly controlled by light grazing with cattle, followed by mowing of the ungrazed weeds. Avoid grazing seedlings when soils are wet. Heavy grazing injures the stand on either wet or dry soils.

Seeding oats as a nurse crop to trefoil as an aid in weed control is not recommended. The nurse crop, like the weeds, robs seedling plants of light, moisture, and nutrients.

Recommended Herbicides

Use the amine salt formation of 4-(2,4-DB) at the rate of 1 to 2 pounds per acre for selective control of weeds, such as ragweed, lambsquarters, pigweed, and mustard. Spray when weeds are still small.

Lespedeza, a serious competitor in new trefoil seedings in some areas, is not well controlled with 4-(2,4-DB), nor are the weed grasses.

Dalapon at 2 to 5 pounds per acre will kill annual weed grasses and lespedeza, and severely injure competing volunteer red clover, alsike clover, and ladino clover. Such a treatment in the spring before weed grasses are more than 3 inches high may give season-long control in Northern States.

Apply herbicides according to instructions on container labels. Do not overdose; overdoses add to the cost of treatment and may damage desirable plants.

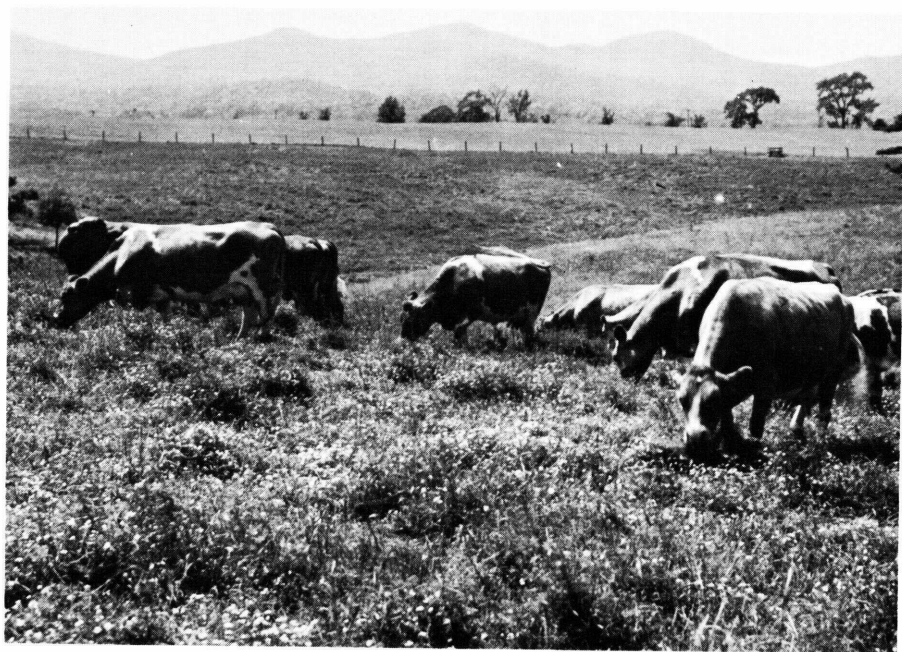
If crabgrass and other grasses germinate during summer, two or more treatments are required. A spring treatment of dalapon followed with another about a month later will usually control grasses for a full growing season. *Do not feed first-year crop of trefoil (that*

has been treated with dalapon) to dairy animals or animals being finished for slaughter. First-year crops should not be sold commercially or shipped interstate.

EPTC, applied at the rate of 2 pounds per acre to the seedbed just before planting and worked into the surface 1 or 2 inches of soil by disking or harrowing, controls many of the broadleaf weeds and all the annual grasses without injury to birdsfoot trefoil.

Combination Treatments

Because broadleaf weeds and weed grasses often occur together in new seedings of trefoil, combination treatments are usually more successful than single applications of herbicides.



Dairy cattle grazing birdsfoot trefoil pasture in midsummer. (Courtesy of New York State College of Agriculture at Cornell University.)

Apply 4-(2,4-DB) at 1 to 2 pounds per acre plus dalapon at 2 to 5 pounds per acre when weeds are still small. If broadleaf weeds persist later in the season, treat singly with 4-(2,4-DB). If only weed grasses continue, apply dalapon alone. If both broadleaf weeds and weed grasses keep growing, apply 4-(2,4-DB) and dalapon in combination again.

Dalapon combined with mowing is also effective for the control of grasses and broadleaf weeds. Apply dalapon at the rate of 2 to 5 pounds per acre, at time of mowing or thereafter before weed grasses get too big.

Control in Seed Fields

Control weed grasses in trefoil seed-production fields with dalapon

applied at the rate of 2 to 5 pounds per acre before trefoil exceeds 6 inches in height. Later treatments may reduce seed production.

Other legumes in seed fields may be controlled by applications of silvex at $\frac{1}{2}$ pound per acre. Apply silvex in the spring. Treatments in spring cause little injury to the trefoil.

If broadleaf weeds are a problem in a seed field, spray with an amine salt formation of 4-(2,4-DB) early in the spring when weeds are small. Apply 1 pound per acre.

On old established stands in the humid Pacific coast region, application of $1\frac{1}{2}$ to $2\frac{1}{2}$ pounds of diuron per acre in the fall gives excellent winter-annual weed control and often takes care of those germinating the following spring.

USES

Pasture and Grazing

Livestock grazing of the trefoils needs to be carefully managed for maximum returns and for uniform regrowth of pasture.

Varieties of birdsfoot trefoil differ in their ability to recover and persist under different systems of grazing. Erect-growing birdsfoot varieties can be completely defoliated by grazing animals unless grazing is controlled. Overgrazed plants gradually lose vigor and die. Remaining stands are thin and unproductive.

Rotational grazing or a system of supplemental grazing is recom-

mended for erect-growing varieties, such as Cascade, Granger, Viking, Mansfield, Douglas, and imported stock from Europe.

To rotation graze, divide birdsfoot fields into three or more pastures and graze in rotation. Make sure that 2 to 4 inches of growth are left at the end of each grazing period. When birdsfoot is growing rapidly, one or more pastures may be cut for hay.

If livestock is continuously grazed on erect-growing birdsfoot, the number grazed should be limited to the number that will leave a minimum of 4 inches of growth on the plants at all times.

Empire and locally adapted strains selected from Empire can be close grazed with less damage than can erect-growing varieties because of their low, spreading growth. Cattle rarely graze off all top growth from these varieties. The leafy stems close to the ground are left and provide nutrients for continued growth. The stems also produce seed that helps maintain stands through natural reseeding.

Many stands of Empire are continuously grazed by beef animals without severe losses in stands.

Sheep, however, are more selective in their grazing and may overgraze birdsfoot if left on it continuously. To graze sheep on birdsfoot, graze three or more fields in rotation or use some form of deferred grazing if other pasture is available.

High-producing dairy cows benefit from the more nutritive forage provided by rotational grazing.

Narrowleaf trefoil and big trefoil are spreading, low-growing plants. In the West, the grazing management for these species is very similar to that for Empire birdsfoot.

Hay and Silage

Although the trefoils are not usually grown for hay alone, taking a cutting of the pasture acreages for hay or silage is often profitable.

Under rotational grazing, the first growth on the last pasture grazed in the first grazing round may be heavy and tall. It usually pays to cut this tall growth for hay rather than graze it because of the loss from trampling and fouling with manure.

Trefoils make high-quality hay; the leafier the cutting, the better the hay. Cut as the yellow flowers come into bloom. Delay cutting until the dew is off plants. Handle all raking, stacking, or baling operations carefully to keep as many leaves as possible.

Windrow and rake the crop 4 to 6 hours after cutting if drying conditions are good. Leaves become brittle and a high percentage of them are lost if raking is delayed beyond recommended time. You can bale windrow-cured hay from the windrow or stack it, depending on equipment available.

Tests indicate that the trefoils make good silage. For specific information on making trefoil silage, consult your county agent or write to your State agricultural experiment station.

Seed Production

Trefoil seed is hard to harvest because the seed pods tend to split open and discharge seed as they mature. Seed harvesting is also complicated by the presence of mature and green pods on most plants throughout the production cycle. Trefoil pods mature at different times because the plants flower over a long period of time.

Seed yields of birdsfoot trefoil are usually low compared with those of other legumes. Reports show yields of 40 to 100 pounds per acre as common in the North Central States. Top yields of 300 pounds per acre have been reported. In California, seed yields range from less than 100 to 425 pounds per acre.

As methods of harvesting trefoil seed have improved, seed acreage and yields have increased, with the result that more adapted domestic seed is available each year, and at a lower price. In the East, New York and Vermont lead in seed production; in the North Central States, Minnesota, North Dakota, and Iowa are the largest producers; and on the west coast, California and Oregon.

Pure Stands Versus Grass Mixtures

To produce certified trefoil seed, plant seed from quality foundation

stock that is as free as possible of other crop seeds, such as alsike, ladino clover, or black medic.

In North Central and Eastern States where severe lodging in birdsfoot trefoil reduces seed yields, planting Kentucky bluegrass or timothy in mixture with birdsfoot trefoil cuts down lodging and increases seed yields. Where no lodging occurs, there is no advantage in mixtures over pure stands.

On the west coast, grasses are of little value in increasing trefoil seed yields. Only pure stands of birdsfoot trefoil are recommended for seed fields under irrigation.



Cutting and windrowing an 18-year-old stand of birdsfoot trefoil and timothy at Preston Hollow, N.Y. Planting timothy in mixture with trefoil reduces lodging and increases trefoil seed yields in this area. (Courtesy of New York State College of Agriculture at Cornell University.)

Pollinators

Most trefoil seed is produced by cross fertilization of the flowers by insect pollinators. Good yields depend on an adequate number of pollinating insects.

Honey bees are effective pollinators of trefoil flowers, and are generally used when native pollinating insects are not present. An average of one honey bee per square yard is enough to pollinate all flowers. On this basis, one average-size colony of bees can pollinate the flowers of an acre of trefoil.

Harvesting the Seed Crop

The first crop of trefoil is usually harvested for seed. Seed yields are lower when the first crop is taken for hay and the second crop for seed. Two seed crops may be possible in some areas of the West.

Observe seed field to decide when to harvest. Pods mature approximately 30 days after the plants flower. Warm, dry weather hastens maturity 2 to 4 days. Cool, moist weather delays maturing of the seed. High humidity reduces shattering.

Harvest when a large percentage of the pods are light brown to brown and before much shattering takes place.

Three methods of harvesting are used:

- Mowing before combining.
- Direct combining.
- Direct combining after defoliation.

Mowing before threshing and direct combining after defoliation are more satisfactory and yield con-

siderably more seed than direct combining.

Mowing before combining.—Mow before the dew is off to reduce shattering. Use a mower with a swather attachment. Leave in the swath until dry enough to combine. If weather is dry and warm with low humidity, 8 hours in the swath may be long enough. Under more humid conditions, allow 24 to 48 hours of drying time before combining.

Direct combining.—Birdsfoot and narrowleaf can be direct combined to a limited extent in some areas. If the crop is not lodged, most seed pods will be in the upper parts of the plant and you can get fair to good seed yields. Because of the rank, leafy growth of the crop, direct combining is slow and difficult, and seed loss is high. The acreage that can be combined per machine is necessarily limited.

Immediate precautions must be taken to avoid heating of the seed because of the high moisture content of inert material, mainly green parts of combined plants.

Direct combining after defoliation.—Generally the most successful way to harvest trefoil seed is to defoliate the green trefoil plants with chemical sprays and then direct combine. The chemical sprays cause foliage to drop off, wilt or lose enough moisture to permit harvesting before pods shatter much.

The time required after defoliation and before combining depends on kind and concentration of defoliant used and on weather conditions. For specific information on

the use of defoliant, contact your state agricultural experiment station or county extension agent.

Screening and Storing Seed

Screen freshly combined seed immediately. Remove green stems, pods, leaves, and other wet matter. Separation of seed from white and alsike clover seed takes time and patience. On the Pacific coast, hopclover seed is often a contaminant in trefoil seed.

Moisture content in the seed itself may be high. Damp, inert material may be mixed with it. Scalp off inert material before drying.

Spread screened seed out to dry.

Watch seed carefully for heating and molding. Have tests made for germination.

Store seed in small lots until it is dry enough to permit cleaning.

Scarifying Hard Seed

Birdsfoot trefoil seed lots containing more than 15 percent of hard seed should be scarified before seeding. The seed coat of hard seed is impervious to water and slow to germinate.

Use care in scarifying seed. Excessive scarification injures seed and lowers germination and seedling growth.

Seed viability is usually reduced when trefoil seed is mechanically scarified and then stored. Scarification by infrared heat treatment appears promising because it reduces the number of hard seed without loss of viability in storage.



VT818

Harvesting birdsfoot trefoil seed with a self-propelled combine from windrow. Direct combining is most successful if green trefoil plants are defoliated by chemicals before combining.

DISEASES AND INSECT PESTS

No disease-resistant varieties of the trefoils have been developed. The most destructive disease of birdsfoot trefoil and big trefoil is caused by soil fungus that incites foliar blight and crown and root rots. The disease can be controlled to some extent by harvesting the crop at the earliest sign of infestation.

Leaf spot and stem canker is another foliar disease commonly found on birdsfoot trefoil. Leaves drop prematurely. When the fungus is seedborne it kills young seedlings.

In the Southeast, big trefoil and birdsfoot trefoil are attacked by nematodes. Affected plants become

stunted and yield poorly. No resistant varieties are grown.

The meadow spittlebug is probably the most injurious pest attacking birdsfoot trefoil in the Middle West and East. Potato leafhoppers and alfalfa plant bugs also suck birdsfoot trefoil plant juices and cause foliage decay.

Other pests that may damage birdsfoot at times include: *Lygus* bugs, stink bugs, grasshoppers, cutworms, and seed chalcids.

For information on disease and insect control of trefoils in your area, write to your State agricultural experiment station or to the U.S. Department of Agriculture, Washington 25, D.C., or ask your county agricultural agent.

Herbicides Recommended in This Bulletin Are:

Common name	Chemical name
4-(2,4-DB) -----	4-(2,4-dichlorophenoxy) butyric acid.
Dalapon -----	Sodium salt of 2,2-dichloropropionic acid.
Diuron -----	3-(3,4-dichlorophenyl)-1,1-dimethylurea.
EPTC -----	ethyl <i>N,N</i>,di-<i>n</i>-propylthiolcarbamate.
Silvex -----	2-(2,4,5-trichlorophenoxy) propionic acid.